

## Ecosystem Management and Forestry

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**Abstract:** In this paper, the conceptions and developments of ecosystem and ecosystem ecology were reviewed and summarized. Then, the conception, connotation, objective, and development of ecosystem management were expounded. Based on these discussions, forest ecosystem management was discussed. The viewpoint was that the former unreasonable forest resources management should be changed, and forest ecosystem management was a suitable way to sustainable development of forestry. The chief research contents were also pointed out in this paper.

**Key words:** Ecosystem, Ecosystem management, Forest, Forestry, Sustainable development

### Introduction

Environment and development are two important problems, which cause a global concern. Ecological environment protection and sustainable development have a direct bearing on the destiny of human and the future of the earth, and influence every country, every nation and every people. Forestry, which undertakes double missions that are to optimize the environment and promote the development, is the crux and the link to realize the unity of environment and development, and its effect can not be replaced in the sustainable development.

China is a developing country with a population of 1.25 billion. It is poor in forest and has a lot of environment problems such as insufficient total amount of forest resources, serious soil erosion, desertification, water resources in short supply and frequent natural calamities. What is more, the enormous population and its increasing tendency cause a grave pressure on the forestry.

Although the state's effect and the improving of the whole people's ideologies are very important to develop the forestry construction, the guiding importance of the research and the outcome by the forestry worker and the ecology worker on forestry development can not be ignored. From irresponsible denudation causing punishment by the nature, to developing artificial forest and even the "industrial economic forest", and furthermore, to ecological forestry, new forestry, forest ecosystem management and vegetation recovery, the public's understanding on social, economic, and ecological benefits of forest resources are gradually thorough with the development and

application of some forestry theories. So, some countermeasures, which are more suitable to sustainable development of forestry, have been more concerning the ecological and social value of forest.

### Ecosystem and ecosystem ecology

The term "ecosystem" has a long history, but some ecologists had comment on the history of ecosystem and believed that ecosystem ecology was given birth from Lindeman's thesis "The trophic—dynamic aspect of ecology"(McIntosh 1992). Undoubtedly, ecosystem ecology is a main current and plays a leading role in current ecology, providing theory foundation for agriculture, forestry and environmental sciences.

Being a basic unit that "could united ecologists", ecosystem had been recognized as functional units of nature or one of them. An ecosystem is often defined by certain researcher who devotes to study in a concrete area of it. Certainly, the ideal way to study an ecosystem is to unite all the components with integration thought. Actually, ecosystem is the only true level of biological integration above the individual.

One of the major achievements of ecosystem ecology is its contribution to the idea "ecosystem is indeed very complex". Compare to traditional ecology study, ecosystem ecology is no longer in a small scale with low cost. Some research programs, such as IBP and MBA, boosted ecosystem study to a process in a large scale with high cost, which is also determined by complexity of ecosystem (McIntosh, 1992). Although theory and methodology of ecosystem ecology had made great progress, there are still some problems. The facts that some fundamental studies on its structure, function, and dynamics in the level of ecosystem are still not deep enough had produced some obstacles in natural ecosystem forecast and control. Globally, study on optimization of

natural ecosystem management still developed slowly, which told us that study on this respect is an important task facing present ecologists.

### **Ecosystem management: connotation, content and development**

The concept of ecosystem management (Ad hoc Committee on Ecosystem Management, Ecological Society of America 1995; Thomas 1994; Zhao 1997) born and developed gradually along with ecology science. The sustainability of ecosystem has become a crucial target of ecosystem management in the journey seeking harmonious development of human being and nature.

Ecosystem management is a serious managing activity aimed at a sustainable development and its application should be guarded by policy, contracts, and factual measurements. On the basis of best awareness to necessary ecological actions and ecological processes that maintain components, structure and functions, ecosystem management focus on studying and monitoring, ensuring the suitability of management. Ecosystem management must include following aspects.

- (1) Long term sustainability is the prime condition to ecosystem management.
- (2) Besides, the study objective can be monitored.
- (3) The complexity and correlation of ecosystem are the basis of the realization of ecosystem functions.
- (4) Dynamic development is the core of ecosystem management.
- (5) For ecosystem management, special space scale and time frame don't exist.
- (6) Human is a part of ecosystem.

From above, we know ecosystem management differs from those managing activities in common sense because it reminds human being paying attention to his management. Ecosystem management is the only approach to realize sustainable development, since its importance can be proved by the facts that sustainable development depends on reasonable use of renewable resources, especially the biological resources.

It is commonly recognized that ecosystem equilibrium and stability in ecological processes are important theory in studies of ecosystem management. In the past, resource management held the hypothesis that there exists stable or ideal ecological equilibrium. Yet, experiences and some studies showed that both situations within or without balance can be observed in certain time and space scale. Ecosystem can't keep static without any turbulence forever, and it can maintain its stability in a certain limit. Since dynamic development can safeguard ecosystem's continuity,

ecosystem management should keep on justify its strategy in accordance with it.

Being a core of ecosystem's sustainable development and productivity, biodiversity must be take into consideration and be an unalienable part in ecosystem management plan (Hansen 1991; Zhao, 1997). In ecosystem management, paying attention to biodiversity means not only conservation but also its function in ecosystem. These two aspects should be crux in biodiversity study.

Summing up, a big part of fundamental theories of ecosystem management came from knowledge related with ecosystem such as structure, function, process, dynamic balance, and biodiversities of ecosystem. Furthermore, most activities of ecosystem management should be guided by these ecosystem principles. Besides, ecosystem modeling is another important part of ecosystem management. When systematic analysis and mathematics model is used in ecosystem ecology, it has deduced some important condensed thoughts through copying the inner complexity of ecosystem with complex language and mathematics form. A good model could help us understand how ecosystem works so that provides suggestions on ecosystem control. As we all know, a successful ecosystem model need coefficients obtained from long time observation, so setting up a long term ecology research net to provide those coefficients is an important task for ecosystem study and ecosystem management.

Although ecosystem management based on knowledge related to ecosystem ecology, some social, economic and humanity factors should often be take into account in ecosystem management.

Because of importance, urgency and complexity of ecosystem management, ecosystem management is not only a science related with ecosystem ecology, but also should be take into consideration in national policy making and in studies of other sciences. For example, study on soil and water conservation research from ecosystem and watershed aspects is the main research contents in North America. It mainly aims at natural resources management in watershed and ecosystem. Its major study fields include structure and health assessment of ecosystem, modeling and study on function and mechanism of watershed and landscape ecosystem, effects of social and economic factors of resource management on sustainable utilization of farmland, and use of practical new methods and technology in soil and water conservation. "Global challenges in ecosystem management in a watershed context", which is a symposium held in Canada in 1997, points out this tendency.

Similarly, integrating forestry or forest resources management with ecosystem management and managing forest as an ecosystem are very important

in both theory and practice.

### **Sustainable forestry and forest ecosystem management**

Forest is a kind of biological community in which trees and other woody plants are main part. As the chief type and component part of land ecosystems, forests are very important to natural environment and human.

Early attempts to conserve sustain wood supplies were largely unsuccessful because biological principles were not an adequate basis on which to develop successful sustained yield forest management. Now, a viewpoint that forests have ecological, economic and social benefits is commonly accepted. The thoughts of forestry production are changing from single-objective forest management to multi-objective management, new forestry and ecological forestry.

New forestry theory takes the principles of forest ecology and landscape ecology as a basis, and admits the reasonable contents of traditional forestry. The management objective of new forestry is to realize the uniting of forests' ecological benefits, economic benefits and social benefits, and to construct the forestry with multiple ecological-social benefits. This kind of forestry can not only produce timber and other forestry productivity sustainably, but also protect biodiversities and improve natural environment. The most obvious characteristic of new forestry (Kimmins 1992; Franklin 1993; Hopwood, 1991) is to regard all the resources of forest as a whole, emphasis maintain and improve the diversities of forests, and stand for combining production and protection as an entirety.

From the definition of sustainable development, the conception of sustainable forestry should be "forestry that do not impair and weaken the satisfaction with requirement for forests' multiple resources of this generation and the future generations in a certain region". The forests' multiple resources include not only material such as timber and other forestry by-product, but also some moral aspects such as forest environment, forest tourism, and its cultural and aesthetic values. In fact, it means the economic, ecological, and social benefits of forest. The forest resources are the basis of forestry, and sustainable forest resources management is in essence the core of sustainable forestry. J. S. Maini from Ministry of Forest and Environment, Canada defined sustainable forest resources management as "maintaining production capability, renewability, species diversity, and ecological diversity of forest ecosystem for a long time". Namely, sustainable forest resources management concerns three important factors: productiv-

ity, renewability, and biodiversity (Lü 1997).

Forest ecosystem management is, with a basis of ecosystem management, some management aiming at forest resources and all the forest ecosystem, and it is the management for living and nonliving components, and the whole process of natural and human impact. Forest ecosystem includes all the management and technological measure by which resources can be used sustainably. Concretely, forest ecosystem management includes: ①effective management for forest land, function and structure of forest ecosystem; ②maintaining productivity and renewability of forest land; ③avoiding the unacceptable damage to forest ecosystem and biodiversity. Its extension includes policy, law and an effective monitoring, feedback and deciding system that are necessary to carry out the management. The clear objective of forest ecosystem management is to realize sustained use and sustainable development of every resource in forest ecosystem, and to make the total benefits of forest resources maximum.

An important problem should be pointed out here. To economic benefits and ecological benefits in forest ecosystem management, which is more important? In a certain context, economics and ecology are dancing to different tunes. However, in a broadest sense, economics is homologous to ecology. Undoubtedly, this viewpoint is worth thinking deeply about.

A valuable viewpoint that managing forests as a kind of resources is also promoted in forest ecosystem management. But there exists a key knowledge that the difference between renewable and nonrenewable resources lies more in the rate or time of their renewal than in the physical, chemical, or biological character of the resource per se. And it is often on a socioeconomic time scale, not a geological time scale (Kimmins 1992; Walters 1986). So, forest resources can be renewable or nonrenewable, and the distinction between renewable and nonrenewable forests is not an absolute one. In many areas it is largely dependent upon the type of forest management employed (Kimmins 1992). Forest ecosystem management must be according to ecological principles, otherwise the renewability of the resource can not be preserved or improved. The quality and intensity of forest management is therefore the key, and managing forestry in different classifications is also an important aspect.

In brief, forest management in different classifications and pursuing forest ecosystem management are necessary to realize sustainable development of forestry. There, certainly, exist some unknown factors in structure, function, productivity, and biodiversity of forest ecosystem. Researching these unknown contents needs forestry and ecology workers' hard work.

Supporting and investing from state are necessary too.

The related studies are the fundament and basis of carrying out forest ecosystem management by the state. Although the research contents as follows have been the studying focal for a period of time, deeply studies on them are necessary yet.

- (1) On forest site.
- (2) On structure, function and stability of forest ecosystem.
- (3) On biodiversity in forest ecosystem.
- (4) On renewability of resources, and deciding the reasonable project for using resources.
- (5) On forest management in different classifications.
- (6) On coverage and conservation of destroyed ecosystem.
- (7) On construction of related policy, law and supporting systems.
- (8) On index system and strategies on sustainable development of forestry.

### **Strategies for sustainable development of forestry**

Forest resources are the fundament for sustainable development of forestry, ecological environment construction is the emphasis, and forestry industry is the guarantee and presupposition. Enhancing consciousness and capacity of sustainable development must be emphasized in strategies on sustainable development of forestry. Then the objective of forestry sustainable development in our country should be to establish social, economic, and technologic guarantee system, to satisfy the need of social development, and to establish the basis of resource, environment and industry suitable for the space-time characteristics of social and economic development. The strategies was formulated previously, and now, they should be adjusted continuously with the development of society and economy, enhancement of popular understanding, and deepening of relative studies.

In fact, implicit in sustained yield and sustainable development is the assumption that the forest is a renewable resource (Kimmins 1992). However, many forests constitute a patchwork of renewable and non-renewable forest conditions. Under conditions of renewability, the sustained-yield concept may be reasonable because the socioeconomic values are eminently renewable. But, in the nonrenewable condition, "timber management" is tantamount to timber mining, and it is unacceptable in the current. Under this condition, effective protections are important, although establishing natural protection zones is not only aiming at nonrenewable forests.

Establishing natural protection zones is the most important measure to protect and research biodiversity. Natural conserve is some region with typical or special value and protected by legal measures. Most of these regions are undeveloped virgin forest, natural species pool, and natural "original value" of ecosystem. Establishing natural conserve to wholly protect the rare existing virgin natural forests is very important, and its deeply meaning and potential benefits are enormous, although the current timber will be decreasing. Undoubtedly, Natural Forest Protection Project unveiled nearly is a great step. Natural forest protection is a new revolution of our forestry and a mark of traditional forest changing into modern forest. Carrying out, expounding and proving the project scientifically are current task with enormous significance.

Summarily, it is a inevitable tendency to change traditional forestry into developing management and protection simultaneously, in spite of difference existing in knowledge. An important policy should be "scientific and reasonable management is the best protection". Natural Forest Protection Project and State-owned Forest Sustainable Development Project both indicate that traditional forestry is looking for new development. In these days of environmental awareness, the profession of forestry is under increasing scrutiny from a critical public. Areas of non-renewable forests, which are our heritage from past logging and "site protection treatments" that proved to be inappropriate the particular site, stand as a mute testimony that in some areas our expectations of sustained yield have been overly optimistic.

### **Conclusions**

Ecosystem management is a serious managing activity aimed at a sustainable development and its application should be guarded by policy, contracts, and factual measurements. On the basis of best awareness to necessary ecological actions and ecological processes that maintain components, structure and functions, ecosystem management focus on studying and monitoring, ensuring the suitability of management. Forest ecosystem management is, with a basis of ecosystem management, some management aiming at forest resources and all the forest ecosystem and it includes all the management and technological measure by which resources can be used sustainably. Forest ecosystem is a complex system, and forest ecosystem management must take maintaining dynamic equilibrium and protecting biodiversity as basis.

Forest resources can be renewable or nonrenewable, and the distinction between renewable and nonrenewable forests is not an absolute one. In many

areas it is largely dependent upon the type of forest management employed. Implicit in sustained yield and sustainable development is the assumption that the forest is a renewable resource. However, many forests constitute a patchwork of renewable and non-renewable forest conditions. So, managing forest in different classification is necessary. Under conditions of renewability, the sustained-yield concept may be reasonable because the socioeconomic values are eminently renewable. But, in the nonrenewable condition, "timber management" is tantamount to timber mining, and it is unacceptable in the current.

Since forestry is a kind of industry, and providing timber is the basic task of forestry, timber production is unavoidable. Natural forest protection differs from natural conserve. Prohibition of cutting may be necessary in a certain area and period, but, for each country and region, whole prohibition is a incompetent step. Harvesting of nonrenewable forests almost certainly constitutes timber mining, and it should be made explicit. However, timber mining is not necessarily an inappropriate management goal. The existing problem is not weather cutting or prohibiting, but how many, where, and how. It is also how to manage and enforce scientifically, reasonably and strictly. For most of the forest resources, scientific and appropriate management is the best protection, and it is important to develop protection and management simultaneously.

Afforestation is an effective measure for vegetation recovery, and in some seriously destroyed area, it is necessary. However, vegetation recovery does not mean afforestation only. Afforestation must be scientific. Besides relationship between sites and plants, biodiversity and developing the multiple functions of forests' multiple resources as huge as possible should also be considered. Otherwise, cutting 100000 hm<sup>2</sup> virgin forest can not be compensated simply by planting 100 000 hm<sup>2</sup> artificial forest. So, reasonable expounding, overall planning, practical activity and effect are all necessary for afforestation and vegetation recovery.

In point of ecosystem, forest is a kind of synthetic resources including timber, animal, plant, and soil.

Genetic constitution and soil resource are two nonrenewable aspects. If particular genotype are lost from the gene pool, they may never be recreated. Soil resource and its nonrenewable aspect is likely easy to be forgotten. The importance of soil resource protection is to maintain the renewability of the plant and animal crops that the soil produces. So, afforestation simply and protection blindly must be avoided in current afforestation and forest resources protection, or hylophilous land protection project will be enforced one day.

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